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Paper 9700/12
Multiple Choice (Core)

Question Number	Key	Question Number	Key	Question Number	Key	Question Number	Key
1	D	11	C	21	D	31	A
2	A	12	D	22	A	32	B
3	B	13	B	23	C	33	C
4	B	14	D	24	B	34	D
5	B	15	A	25	D	35	C
6	D	16	B	26	D	36	B
7	C	17	A	27	C	37	A
8	B	18	C	28	B	38	A
9	D	19	C	29	B	39	D
10	C	20	D	30	A	40	A

General comments

Candidates found Questions **1**, **4**, **8**, **23**, **24**, **27**, **28** and **35** to be relatively straightforward. Questions **2**, **5**, **10**, **11**, **19**, **25**, **26** and **34** were challenging.

Comments on specific questions

Question 2

Nearly all candidates recognised that having small, circular DNA supported a prokaryotic origin. Candidates were less certain in identifying other features in support of the theory. Synthesising their own proteins supports the view that the ancestral organelles were free living and possession of a double membrane supports an endocytic origin.

Question 5

Key to this question was the recognition that it was a combination of features that provided evidence that the cells are plant cells. No individual feature on its own was sufficient. Candidates selecting option **B** (the correct option) had recognised that large cell size was the strongest evidence for eliminating the possibility that the cells were prokaryotes, and that possession of a cell wall eliminated the possibility that the cells were animal cells. Taken together, these features provided the most support for the conclusion that the cells are plant cells.

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Question 9

Most candidates selected the correct option. Option **A** was the most commonly selected incorrect option suggesting that candidates had not noticed the distinction between glycogen and glycerol.

Question 10

Although the question was based in the context of collagen, the key concepts assessed were secondary structure, tertiary structure and quaternary structure of proteins. All options were selected by a significant minority of candidates.

Candidates selecting option **A** had not noted that hydrogen bonding between adjacent polypeptide chains would contribute to quaternary structure, rather than tertiary structure. Those selecting option **B** had possibly confused hydrogen bonding in the secondary structure of proteins between carboxyl and amino groups of non-adjacent amino acids with hydrogen bonding in the tertiary structure, which is between R-groups. Slightly fewer candidates selected option **D**, indicating that most appreciated that hydrogen bonding within the same polypeptide chain cannot contribute to quaternary structure.

Question 11

There was no clear pattern in the responses of candidates selecting incorrect options. A significant proportion of candidates incorrectly thought that glycosidic bonds were involved in holding adjacent cellulose molecules together. Of those who knew that adjacent cellulose molecules are held together by hydrogen bonds, a significant minority incorrectly thought that the cellulose molecules in different layers of the cell wall are organised in a parallel arrangement.

Question 13

Most candidates selected the correct option, but a significant minority selected option **A**. Although some enzymes are formed from several polypeptides, this is not true for all and therefore the active sites of enzymes do not always involve quaternary structure.

Question 14

Many candidates selected option **B**, which was incorrect. Although the results showed that the rate of reaction was fastest during the first 10 seconds of the reaction, there is no data indicating at what point during this 10-second period the rate of reaction would have been fastest. In fact, the expectation would usually be that the rate of reaction would be fastest at the start when the substrate concentration is highest.

Question 19

A large proportion of candidates selected option **B**. It is likely that these candidates had correctly worked out the number of molecules present in the nucleus at the end of interphase but not taken into account that DNA molecules are double stranded.

Question 21

A significant proportion of candidates selected option **A** instead of the correct option. In order for chromosomes to be lined up in metaphase, the spindle must begin to form during prophase.

Question 25

Almost all candidates correctly identified the template and non-transcribed strand in the diagram showing the transcription of DNA with RNA polymerase. However, a considerable number of candidates thought that the RNA strand that was synthesised was mRNA (option **C**), rather than the primary transcript (option **D**). Candidates selecting the correct option had noted that animal cells are eukaryotes and that mRNA is not produced in eukaryotes until the initial product of transcription has been processed further.

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Question 26

Most candidates recognised that growing leaves can act as sources or sinks for sucrose and therefore excluded options **B** and **C**. However, many candidates thought that leaves can only act as a sink for amino acids and selected option **A**. Since mass flow in the phloem will be in one direction, if growing leaves can act as sinks for sucrose they must also be able to act as sinks for all other assimilates, including amino acids.

Question 29

Option **D** was the most frequently selected incorrect option. Although haemoglobinic acid is associated with high carbon dioxide concentration, less haemoglobinic acid will form as oxygen concentration increases. Therefore, there will be a higher concentration of haemoglobinic acid at **B**.

Question 31

Most candidates selected the correct option, but a significant minority selected option **D**. The trigger causing valves to close is when the difference in blood pressure would result in blood flowing backwards. At the point that blood pressure in the left ventricle becomes higher than the blood pressure in the left atrium, blood pressure in the aorta is still higher than the blood pressure in the left ventricle. The semi-lunar valve is therefore closed. The semi-lunar valve in the aorta opens a moment later when the ventricular pressure has increased further and exceeds the aortic pressure.

Question 34

Many candidates thought that a molecule of oxygen in the air would pass through a minimum of either 5 (option **A**) or 6 (option **B**) phospholipid layers as it diffuses to a haemoglobin molecule in a red blood cell. These candidates may not have noted that the question related to phospholipid layers for which there are two for every cell surface membrane (phospholipid bilayer).

Question 38

This question required candidates to identify the type of bond in each diagram and then decide whether this would be present in an antibody molecule. A large proportion of candidates selected incorrect options, but no particular pattern was evident. Candidates selecting option **C** did not appear to have recognised the peptide bond and those selecting option **B** may not have realised that disulfide bonds are important in stabilising the folded antibody structure and holding the different chains together.

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Paper 9700/22
AS Level Structured Questions

Key messages

- In questions assessing osmosis such as **Question 1(e)**, candidates should use the terms 'water potential' and 'water potential gradient'. The terms 'water concentration' and 'water concentration gradient' are not appropriate. The Greek letter ψ (psi) is often used as the symbol for water potential. The units for water potential are the units for pressure and are typically expressed as kPa (kilopascal) or MPa (megapascal).

- Candidates should be as precise as possible in their responses to reflect the depth of knowledge expected from the syllabus content. In **Question 4(b)(ii)**, candidates were expected to use all the information to fully identify the type of immunity as passive artificial immunity. Those referring only to passive immunity or only to artificial immunity had not used all the information provided.

- In questions about transcription and protein synthesis, such as in **Question 5(b)(i)**, the syllabus uses the terms 'transcribed strand' or 'template strand' and 'non-transcribed strand' to identify the two strands of a DNA molecule. These are the terms candidates are expected to use when referring to the two strands of a DNA molecule.

General Comments

Many candidates were well prepared, with a good knowledge and understanding of the syllabus and were therefore able to perform well.

It is important that candidates read the questions with care, note the command words carefully and use the information provided to develop their answers. For example, in **Question 2(c)** candidates were told that there are high proportions of proline and leucine and that they both have hydrophobic R-groups. Using this information correctly would have allowed candidates to address the question.

In **Question 3(a)(ii)**, the question asked candidates to describe the flow of blood. Many candidates included explanations in their answer or used technical terms such as diastole and systole as alternatives to providing relevant descriptions.

When questions require calculations, as in **Question 1(b)**, candidates should, where possible, maintain an awareness of the likely magnitude of answers. Candidates should be prepared to re-check their calculations carefully if calculated answers appear to be outside the expected ranges, which in this case would have been with respect to the expected size of a cell. Some candidates were unable to correctly convert units from millimetres (mm) to micrometres (μm) resulting in significant departures from realistic values. Not all candidates rounded their answers correctly.

Comments on specific questions

Question 1

(a) Many candidates incorrectly considered that the image had been obtained using an electron microscope.

(b) Most responses included correct measurements for distance and recognised the mathematical manipulation required. However, errors in conversion of units or errors in rounding were often apparent.

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(c) The majority of candidates were able to provide an appropriate explanation.

(d) Candidates were expected to recognise the direction of the concentration gradient in determining the type of mechanism involved in the transport of Na^+ and K^+ ions. Not all candidates appreciated that ions cannot cross the hydrophobic core of the phospholipid bilayer, and that simple diffusion could not therefore be one of the mechanisms.

Some confused responses referred to sodium–potassium pumps.

(e) Not all candidates referred to osmosis in their explanations.

Some candidates mistakenly considered that cortex cell **A** had a lower water potential than cortex cell **B** and therefore explained the movement of water in the incorrect direction. Candidates often find it easier to refer to differences in water potential in terms of 'more negative' and 'less negative' rather than simply 'lower' (more negative) and 'higher' (less negative).

(f) (i) A majority of candidates knew that carbon dioxide dissolves in water to form carbonic acid. Many showed an understanding that the acid will dissociate and release H^+ ions, which would lead to a decrease in pH of the soil. Fewer went on to consider that the low pH could cause Fe^{2+} ions to detach from the clay particles.

Some candidates thought that the reaction between carbon dioxide and water in soil water is catalysed by carbonic anhydrase.

(ii) Many candidates recognised the role of the endodermis in diverting the movement of Fe^{2+} ions from the apoplast pathway to the symplast pathway and, of these, most referred to the role of suberin and the Casparian strip in this process. Fewer candidates went on to explain the significance of this for controlling the amount of Fe^{2+} that could reach the xylem. Good responses often referred either to the quantity or activity of transport proteins in the cell surface membranes or to intracellular processes that would restrict the flow of Fe^{2+} ions, such as storage in the vacuoles.

Question 2

(a) Many candidates knew the correct orientation of the –H and –OH on carbon one to distinguish an α-glucose molecule from a β-glucose molecule, and most completed the rest of the structure correctly. A number of candidates did not fully complete the structure with the –H on carbon 5 being the most common omission.

(b) (i) Most responses correctly identified both types of covalent bond.

(ii) Some responses referred only to ligand bonding, which can occur in many contexts other than cell signalling. Further qualification, such as an immediate consequence of ligand binding, was required to adequately state the role of glycoproteins in cell signalling.

(c) Some responses correctly related the high proportion of proline to the lack of availability of sites for localised hydrogen bonding that is required for the formation and maintenance of α-helices and β-pleated sheets.

More were able to explain why β-casein molecules have relatively little tertiary structure. Many responses referred to the low proportion of cysteine residues and the consequences of this for the formation of disulfide bonds. Some also considered how a low proportion of serine and cysteine residues could limit opportunities for the formation of ionic and hydrogen bonds.

Question 3

(a) (i) Many responses recognised that valve **V w**as a semilunar valve or the aortic valve.

(ii) The most effective responses were limited to descriptions of the flow of blood through the heart at the stage shown in Fig. 3.1. A proportion of responses included explanations of what was happening, rather than descriptions, which was not required. Some responses referred to the atrium and the ventricle, rather than atria and ventricles, which did not convey a complete understanding of the flow of blood through the whole heart.

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(b) Many candidates knew the stage of the cardiac cycle shown in Fig. 3.2 and went on to give a correct reason related either to the closed atrioventricular valves or the open semilunar valves.

(c) Many responses gave detailed accounts of the sequence of events that control contraction of the ventricles. Most also noted that both ventricles contract together.

Some responses omitted key events, and not all referred to events in the correct sequence.

Question 4

(a) (i) Most responses clearly stated the defining features of an infectious disease.

(ii) Strong responses used the terms primary immune response and secondary (immune) response to explain why the concentration of antibody was higher after the second injection. Most recognised the role of memory cells in achieving a faster production and a higher concentration of antibodies. Fewer noted that the secondary response developed from a higher starting number of specific lymphocytes or linked memory cells to the formation of plasma cells.

(b) (i) Not all responses fully identified the type of immunity by referring to passive and artificial.

(ii) Many responses recognised that an injection of antibodies would provide immediate immunity, and some went on to explain that this immunity would only be short term or temporary. Some answers included the idea that an immune response would not be involved and so there would be no production of memory cells.

(c) (i) Most candidates were able to recall the names of one of the species of bacteria that cause tuberculosis (TB). Not all were able to spell the scientific name correctly.

(ii) Many responses included two or more relevant features, but few provided a complete answer. Most suggested treating TB with a combination of rifampicin and an indigestion drug, with many explaining that this would improve the effectiveness of the treatment by preventing the bacterium from pumping out the antibiotic through the cell surface membrane. Few developed this further by considering that this would reduce the time needed for a successful treatment and therefore reduce the risk of bacteria developing rifampicin resistance.

Question 5

(a) The majority of responses correctly identified most of the terms.

(b) (i) This was well answered, with most responses stating the correct term.

(ii) Many responses correctly named the term as the primary transcript. Some incorrectly stated messenger RNA or mRNA. In eukaryotes, mRNA is produced only after further processing of the primary transcript.

(iii) Most responses provided the correct sequence of all six bases.

(c) Most responses recognised that inhibition of RNA polymerase by alpha-amanitin was non-competitive and would result in a change in conformation of the active site. Many referred to relevant consequences such as a decrease in the rate of formation of enzyme–substrate complexes and some went on to consider specific effects on the mode of action of RNA polymerase.

Question 6

(a) (i) Most candidates were able to place the letters in the correct sequence.

(ii) Most responses referred correctly to events such as the uncoiling of chromosomes, the formation of a nuclear envelope around each set of chromosomes and the breaking down of the spindle fibres. Some described the appearance of nucleoli in each nucleus.

(b) The majority of candidates completed Table 6.1 correctly.

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Paper 9700/33
Advanced Practical Skills 1

Key messages

Candidates should be given the opportunity to experience a variety of practical work throughout the course so that they can develop the skills that can be applied to the requirements of the examination.

When drawing the observable features of the tissues in a specimen, the drawings must show the correct proportions. Slide **P1** was made up of two main tissues and the large plan diagram should have shown the relative proportions of these layers. The epidermis of **P1** should have been drawn as two lines.

General comments

Candidates should use materials and apparatus during practical work as part of the course in preparation for the examination. Candidates who have had the opportunity to follow instructions carefully in a variety of practical work are likely to find it easier to organise and complete unfamiliar activities.

Many candidates demonstrated that they had a good understanding of the skills required. The majority of candidates showed that they were familiar with the use of the microscope.

Candidates should read the whole of each question carefully before attempting an answer; this should help them to plan their time carefully and identify the precise requirements.

Comments on specific questions

Question 1

(a) (i) The majority of candidates stated the temperature of the water in the water-bath and three other temperatures to be used, as required by the question. Stronger candidates selected temperatures that were separated from one another by at least 5 °C.

(ii) The majority of candidates recognised that the test-tube was left in the water-bath for two minutes so that the contents reached the same temperature as the water-bath.

(iii) The majority of candidates organised their results clearly in a ruled table with headings for temperature / °C and time / s. Most recorded times for the temperatures tested to an appropriate degree of precision (whole seconds) and obtained the correct trend.

(iv) Most candidates correctly stated that the dependent variable was the time taken to reach the end-point.

(v) Many candidates correctly described the trend. Stronger candidates explained the results by considering how temperature affects the kinetic energy of ascorbic acid.

(vi) Some candidates correctly explained that repeating the procedure several times increases confidence in the results by allowing anomalous results to be identified or by allowing a statistical test to be applied.

(vii) Many responses recognised that cubes of different sizes should be used and that all cubes should be tested at the same temperature. Not all responses were clear that only a single temperature should be tested.

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(b) (i) Most candidates correctly used the headings given in Table 1.3 to label the *x*-axis (time / minutes) and the *y*-axis (concentration of radioactive glucose / mmol dm^{-3}). Some candidates labelled the incorrect axis or gave incomplete headings.

Many candidates used appropriate scales for the *x*-axis and the *y*-axis, but a few errors in scaling were seen.

Most candidates plotted the points accurately and joined the points appropriately with a thin line.

(ii) Many candidates correctly showed on their graph how to estimate the concentration of radioactive glucose in the red blood cells at 50 minutes.

(iii) Many candidates correctly referred to diffusion to explain why the concentration of radioactive glucose in the red blood cells increased over time.

Question 2

(a) (i) The majority of plan diagrams were drawn to an appropriate size that filled most of the space available and showed the distribution of different tissues. A small number of drawings showed individual cells, which was not appropriate.

Most candidates followed the instructions by drawing only the part of the stem section specified in Fig. 2.1. Many candidates included at least two wide layers of tissue within the stem. Stronger candidates additionally used two lines to show the epidermis as a thin tissue of relatively uniform thickness.

Some diagrams showed the vascular tissue in bundles, which was incorrect.

Most candidates were able to identify the xylem by labelling the correct layer on their diagrams.

(ii) The majority of candidates followed the instructions to draw a group of four adjacent cells from the cortex, with each cell touching at least two other cells. Most of these candidates completed their drawings using a sharp pencil to produce thin lines that joined up precisely when enclosing entire structures. Many used most of the space available.

Stronger candidates used two lines to represent the thickness of cell walls and represented the shape of the cells correctly.

The most common error was for candidates to draw lines that did not meet up precisely or that were too thick.

Most candidates correctly labelled the cell wall.

(b) Many candidates identified three observable differences between the stem on **P1** and the stem in Fig. 2.2, and described these clearly in an appropriate table using one row for each difference.

(c) (i) Most candidates accurately recorded the lengths of line **R–S** and line **T–U** with appropriate units, before correctly calculating the actual size of these lengths for the specimen.

(ii) The majority of candidates correctly showed how they calculated the actual area of the section using the provided equation. Not all expressed their answer to two significant figures as required by the question and some did not use appropriate units.

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Paper 9700/42
A Level Structured Questions

Key messages

- Candidates should answer with precision to avoid ambiguity. For example, if referring to the outer membrane of a cell (e.g. in a response to **Question 6(b)**), this should be identified as the cell surface membrane to distinguish it from any of the other cell membranes found throughout eukaryotic cells. Similarly, in **Question 10(a)**, references to depolarisation must make it clear what is being depolarised.

- Candidates should take notice of the command word in a question and ensure that their answers address the assessment intent. For example, 'describe', 'explain' and 'suggest' have distinct meanings and require different types of responses. Meanings of command words are explained in Section 4 of the syllabus.

- In questions using the Hardy–Weinberg equation, candidates should be aware that the values of p, q, p^2, $2pq$ and q^2 can never be negative or greater than one. Any value outside of this range indicates that there is an error in the calculation.

General comments

Many candidates demonstrated detailed knowledge and understanding across a broad range of topics and were able to articulate responses clearly and analyse data effectively.

Candidates found **Questions 6** and **7** relatively straightforward. Many candidates found **Questions 4** and **5** to be more challenging.

Comments on specific questions

Question 1

(a) Candidates were asked to identify the approximate energy value of three main respiratory substrates. Few were aware that lipid has the highest energy value.

(b) (i)(ii) Most candidates were able to state the name of the apparatus that can be used to determine RQ values. Many were able to state the reasons for using chemicals such as soda lime or potassium hydroxide solution.

(c) (i)(ii) The majority of candidates were able to balance the equation and use this information to calculate the RQ for malic acid.

(d) (i) This question required candidates to describe the trend in RQ values during torpor before suggesting an explanation. Some described the fluctuating line in detail, which obscured the clear expression of the overall trend. Very few responses linked the decrease in RQ values with a change in respiratory substrate from carbohydrate to lipid.

(ii) Strong candidates recognised that periods of torpor in the year might be linked with seasonality and were able to suggest reasons for torpor based on environmental factors such as temperature. Many, however, did not make this link and struggled to suggest explanations for periods of torpor.

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Question 2

(a) (i) Most candidates were able to use the information in Fig. 2.2 to explain why this type of speciation is sympatric. Some referred to features of sympatric speciation that could not be deduced from the figure, such as behavioural isolation.

(ii) Differences in diet and differences in mating behaviour were the two most frequent examples of behavioural separation suggested by candidates. Fewer candidates identified other examples, such as differences in social group sizes.

(b) (i) Nearly all candidates identified at least one difference between the Type **B**, Type **C** and Type **D** orca. The black colouration present along the back and dorsal fin of Type **B** and Type **C** orca, but absent from Type **D** orca, was the most commonly stated difference.

(ii) Responses to this question were very variable. Strong responses recognised that genetic drift was related to the isolation of a small population in which allele frequencies change as a result of chance.

A number of candidates described phenotypic changes that would happen over time due to the action of selection pressures. Such changes are the result of natural selection, rather than genetic drift.

Some suggestions were too vague, e.g. monitoring the habitat of a species without stating what aspect of the habitat would need to be monitored.

Question 3

(a) (i) Most candidates noted that *Taq* polymerase can withstand high temperatures, and many linked this to a high optimum temperature. Fewer knew the optimum temperature of *Taq* polymerase and only the stronger candidates appreciated the importance of tolerance to high temperatures in allowing *Taq* polymerase to remain active through repeated PCR cycles where exposure to high temperatures occurs during the denaturation step.

Descriptions of the role of *Taq* polymerase in PCR were frequently limited and often omitted relevant details such as the enzyme's role as a DNA polymerase and its interaction with specific primers.

Many responses referred incorrectly to transcription instead of DNA synthesis.

(ii) Many candidates correctly interpreted the results of gel electrophoresis and deduced that child 2 should not be given gentamicin to treat severe bacterial infections. Fewer candidates recognised that this was also true for child 4, suggesting that they had not noted from the information provided that any child with the mutated allele would be affected by gentamycin, not just homozygotes.

(iii) Many responses noted that DNA fragments were negatively charged so would move to the anode (positive electrode) and that smaller DNA fragments would move more quickly. Fewer combined this understanding with relevant details of the different PCR products to explain how this would produce the pattern of results shown in Fig. 3.1.

(b) The majority of candidates stated that plasmids could be transferred from one bacterium to another, often using a scientific term such as conjugation or horizontal transfer. Incorrect responses referred most frequently to binary fission, which transfers plasmids vertically to daughter cells but not horizontally between existing bacterial cells.

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Question 4

(a) Most candidates recognised that both parents needed to be heterozygous for the C282Y allele and used a genetic diagram to show how a child with hereditary haemochromatosis could be produced.

Several responses omitted to state which of the offspring genotypes would result in a child that could develop haemochromatosis, often only stating that there was a 25% probability of any child from this cross having the condition. Terms such as 'carrier' are descriptions of the genotype rather than the phenotype and were used in some responses without further qualification.

A few candidates had not noted the information in the question that hereditary haemochromatosis is an autosomal recessive condition and attempted an explanation based on X-linkage.

(b) Stronger responses typically referred to the use of bioinformatics or information available in biological databases to locate the C282Y allele in DNA sequences obtained from the fossil skeletons.

Weaker responses often considered alternative techniques such as microarrays or gel electrophoresis, despite information in the question clearly stating that the data analysed were obtained from DNA sequencing studies. Some candidates suggested approaches based on protein sequencing.

A number of responses were simply re-wordings of the information provided in the question.

(c) (i) This was a challenging question. Although many responses recognised that maintenance of the C282Y allele would require individuals with the mutation to survive and reproduce, few appreciated that this could be linked to the selection pressure for low-iron diets.

Strong responses considered the role of directional selection and recognised that heterozygotes were not at a disadvantage.

(ii) Most candidates recognised that the percentage of people in each country with a single C282Y allele decreased from west to east across Europe and many linked this to migration of individuals from the west. Few candidates used the information that the allele originated in Ireland to explain why this was the country with the highest percentage of people with this allele.

Some responses noted that differences in diets would affect the strength of the selection pressure and that this would contribute to differences in frequency of the allele between European countries.

(d) Most responses focussed on how differences in the types of population recruited into the databases, such as their geographical location, could lead to the differences shown.

The existence of different mutation rates was a common incorrect suggestion.

(e) Many candidates were able to apply the Hardy–Weinberg equation to calculate the number of heterozygotes.

Frequent errors included identifying q as the frequency of the recessive genotype instead of the frequency of the recessive allele, not multiplying $2pq$ by the population size to derive the number of people heterozygous for the *HFE* and premature rounding of intermediate steps in the calculation. In calculations involving multiple steps, rounding should be avoided until the final answer has been obtained.

Question 5

Describing the stage of meiosis shown in Fig. 5.1 proved challenging for many candidates. Many did not note the statement that the photomicrograph was of a single plant cell and interpreted the image as two cells in meiosis I. Others considered that the photomicrograph was showing telophase II.

Of the candidates recognising the stage as anaphase II, descriptions of the events associated with this stage were often limited to the pulling of the chromatids to opposite poles of the cell.

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Question 6

(a) (i) The majority of candidates correctly identified **P**, **Q** and **R**.

(ii) Nearly all candidates were able to state the type of homeostatic control mechanism.

(b) Many responses demonstrated a good understanding of the role of glucagon in controlling blood glucose concentrations. Strong responses described the main events in detail, starting with the binding of glucagon to a cell surface membrane receptor and continuing in the correct sequence.

Weaker responses included many of the key points, such as the name of the hormone and the breakdown of glycogen, but omitted others and did not always present events in a clear sequence.

Question 7

(a) (i) Most candidates read off the relevant values from the graph and completed the calculation accurately. Common errors included mis-reading values from the graph and dividing by an incorrect figure for the number of years.

(ii) This question was well answered by many candidates. Most focussed on the control of hunting and trade but suggestions to set up national reserves for the tiger coupled with education programmes were also commonly seen.

A significant minority of candidates described aspects of captive breeding programmes even though careful reading of the question would have made clear that this approach was precluded.

(b) Candidates showed a good understanding of the importance of maintaining animal biodiversity. Responses were wide ranging and included ethical and aesthetic reasons, ecotourism and the need to maintain gene pools and ecosystems.

Some candidates did not realise that the question was only about animal biodiversity and gave descriptions of the benefits of plant biodiversity.

(c) Nearly all candidates could sequence the events of an IVF procedure.

Question 8

(a) Most candidates were able to name decarboxylation and dehydrogenation as the two types of reaction that take place in the link reaction.

(b) While most candidates correctly noted that the activity of citrate synthase was reduced in the presence of succinyl-co A, a significant minority did not develop their responses further.

Many candidates attempted to support their responses with data quotes from the graph, but data quotes were frequently inaccurate and incomplete. To define any data point clearly, both the *x*-axis and *y*-axis coordinates must be given,

The strongest responses recognised that succinyl-coA was acting as a competitive inhibitor and explained how this could help to regulate the Krebs cycle.

A common error was to identify succinyl-coA as a non-competitive inhibitor, ignoring the statement that succinyl-coA has a similar shape to acetyl-coA.

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(c) NAD is best regarded as a hydrogen (atom) carrier rather than an electron or proton carrier but, irrespective of how candidates referred to NAD, most correctly recognised that it is reduced in aerobic respiration. Candidates who went on to state that this occurred in glycolysis (as well as the link reaction and Krebs cycle) had not noted that the question was restricted to the context of the mitochondrion.

Few candidates were able to articulate the role of NAD in moving hydrogen to the inner mitochondrial membrane where it is released for oxidative phosphorylation. Several candidates gave details of the electron transport chain that were not relevant.

Although many referred to the oxidation of reduced NAD at the end of this process, this was missed by a significant proportion of candidates.

Question 9

(a) While recognising that chlorophyll *b* is an accessory pigment that absorbs light, many responses did not explain the significance of this in that the wavelengths absorbed are different to those absorbed by the primary pigment. This is important for extending the range of wavelengths that can be used for photosynthesis.

A common error was to state that the accessory pigments pass light on to the reaction centre, rather than energy.

(b) (i) Candidates were asked to describe the results of the experiment. Few described the shape of the curves accurately to reflect the fact that the rate of production of oxygen increased with light intensity at first and then levelled off. Most stated that the mutant plant had a higher rate of photosynthesis than the normal plant, but many did not support this statement by quoting data from the graph.

(ii) Most responses noted that more light would be absorbed by the mutant plants leading to a higher rate of photosynthesis as a result of the greater production of ATP in the light-dependent reactions. Fewer considered the importance of an increased production of reduced NADP.

Only stronger responses related the increase in the rate of photosynthesis to increased growth through increased production of triose phosphate for the synthesis of biomolecules and transfer of energy.

Question 10

(a) Many responses included relevant details to describe how a neurotransmitter would be released by the cell. Some omitted to describe how sodium ion accumulation led to the entry of calcium ions but described all subsequent steps. Others described earlier steps in the process up to the generation of an action potential, but did not progress beyond this point.

(b) Most candidates provided full accounts.

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Paper 9700/52
Planning, Analysis and Evaluation

Key messages

It is important to carefully read each question before starting to write.

When planning an investigation, the plan should be set out in a logical way and with sufficient detail for another person to follow. In preparation for the exam, candidates should practise writing plans for laboratory-based investigations and also for ecological investigations.

Candidates should be clear whether statistical analysis is looking for differences or correlations and take care to always use the correct terminology.

General comments

Candidates should check their answers carefully to ensure that relevant details have not been omitted. For example, in **Question 1(a)** many candidates who understood the principles of the mark-release-recapture method did not state that the method would require the number of bush crickets captured to be counted.

It is important that candidates understand the requirements of the different statistical tests that can be assessed and the conditions in which each of the tests may be valid. Not all candidates were aware of these requirements for the Spearman's rank correlation in **Question 2**.

Comments on specific questions

Question 1

(a) This question was well answered, and most candidates were able to outline several aspects of the mark-release-recapture method.

Some responses omitted important details. For example, it was not always clear that the number of bush crickets in the first and second captures were counted, or that the number of marked bush crickets in the second capture were counted.

Many candidates included additional relevant details, such as the idea that the method of marking must not be harmful to the crickets. Others stated a suitable time between the first and second captures. Although candidates were not expected to know a specific figure for a suitable time interval, intervals of just a few hours or exceeding a period of several months were outside of acceptable ranges. Suggestions referring only vaguely to a period of time were insufficiently precise.

Candidates do not need to memorise the formula for the Lincoln index, but some made use of the formula to describe the method. Where candidates used symbols for the Lincoln index that did not correspond to those used in the syllabus, it was essential that the symbols were explained, for example with a key.

(b) Most candidates correctly calculated Simpson's index of diversity (*D*) to three significant figures. A few candidates expressed *D* to an incorrect number of significant figures.

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(c) (i) Many candidates were able to suggest at least one abiotic factor that could be monitored. Some suggestions were too vague and required further qualification, for example carbon dioxide levels, water availability and soil nutrients. It must be clear what is to be measured.

A small number of candidates confused abiotic factors with biotic factors.

(ii) This question was well answered. Many candidates described a suitable method to investigate changes in the species diversity of the plants in the grey dune ecosystem during the ten-year period after conservation practices were introduced. Several developed thorough plans that included details of appropriate sampling techniques. Random or systematic sampling techniques were both valid approaches.

Some candidates referred incorrectly to quadrats as quadrants.

Several candidates recognised that the size of the quadrat should be the same throughout the whole investigation. Not all stated appropriate dimensions of quadrats for sampling the grey dune system. Quadrats less than 0.5 m × 0.5 m would be too small to identify a variety of plant species, while quadrats larger than 2 m × 2 m would be impractical.

More detailed responses considered how to ensure that all plant species, including those that are small or likely to be hidden under other larger species, were counted. Some candidates referred to appropriate ways to identify the species of plants present.

It was not always clear that the number of individuals of each plant species present in the quadrat should be counted. Many candidates considered the need for replication, but details were often vague or did not amount to meaningful replication, e.g. planning to carry out repeat counts in the same quadrats rather than sampling new quadrats.

Consideration of sample sizes and frequency of sampling was also important. The strongest responses specified that sampling should be carried out every year and at the same time each year to allow a valid comparison of species diversity over the ten-year period. Some responses also considered the relevance of sampling at different times of the year to account for seasonal variation.

The majority of responses incorporated some form of risk assessment. Many candidates mentioned a range of potential hazards including allergies to plants, trip hazards in the grey dune ecosystem, high sun exposure and insect bites. Complete assessments of risk should include reference to the hazard and its associated consequence, together with a suitable method to mitigate the risk.

Question 2

(a) Strong responses identified two conditions from the details provided that supported the use of Spearman's rank correlation in this investigation. Many recognised that the data could be ranked and that the coffee farms were chosen at random. Fewer appreciated that the observations were paired.

(b) Many candidates were able to state a suitable null hypothesis. One of the most common errors was to state that there was no difference, rather than no correlation, between water availability on each farm and the number of months that elephants entered each coffee farm per year.

Not all responses recognised the significance of paired observations and referred to correlation between water availability and the number of months that elephants entered coffee farms per year, instead of treating each coffee farm as a separate piece of data.

(c) (i) Most candidates were able to use Table 2.3 to accurately complete Table 2.2.

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(ii) In **2(c)(i)**, most candidates had already identified that the relationship between the density of December trees and the number of months that elephants entered each coffee farm per year was not significant. This should lead to acceptance of the null hypothesis that there was no correlation. Some candidates who had identified that there was no significant correlation stated that there was a negative correlation. This was only accepted if further qualified with the indication that the negative correlation was weak.

(d) Many responses referred to the significant positive correlation between water availability and the number of times that elephants entered each coffee farm as support for the conclusion. Stronger responses went on to state that water availability was the only variable found, of those tested, to have a significant correlation.

On the other side of the argument, many candidates also identified limitations in the investigation that reduced support for the conclusion. For example, water bodies were only counted in March 2008, the investigation was limited to the Nagarahole National Park and no account was taken of the size of the ponds, lakes and water holes. Others referred to the lack of data about the actual number of elephants that entered each coffee farm per month.

Several candidates correctly stated that correlation does not indicate causation and recognised that other factors may explain an apparent link between the frequency of elephant visits and the availability of water.

Question 3

(a) Many candidates found it difficult to correctly express the independent variable in this investigation. References to 'vaccination against *Rotavirus*' were too vague without further qualification. Phrases such as 'vaccination status' or 'whether the vaccine was given' were required to define the independent variable adequately.

Most candidates correctly stated that the dependent variable was the number of children with type 1 diabetes (per 100 000).

(b) (i) Many responses identified a decrease in the proportion of children aged 0 to 4 years with type 1 diabetes after the introduction of the *Rotavirus* vaccine. Others recognised that in the years before the introduction of the vaccine and in the years after the introduction of the vaccine, the incidence of type 1 diabetes in children of this age was increasing from year to year. Few responses stated both conclusions clearly.

Responses were sometimes too imprecise. For example, references to increases in the incidence of type 1 diabetes in children needed to be linked to relevant years due to the decrease in incidence as a result of vaccination. Similarly, some candidates referred to '*Rotavirus*' when they meant to refer to the '*Rotavirus* vaccine'.

(ii) Many responses referred to a fall in the incidence of type 1 diabetes in children aged from 0 years to 4 years after the introduction of the *Rotavirus* vaccine as evidence in support of the conclusion. Strong responses went on to note that the 95 per cent confidence intervals for children aged from 0 years to 4 years did not overlap, indicating a significant difference. Weaker responses only referred to the error bars not overlapping without further qualification.

Few candidates appreciated the relevance of the data for children aged from 10 years to 14 years. This group of children could be considered to be a control group because none had been vaccinated against *Rotavirus*. Responses often noted that the 95 per cent confidence intervals for children in this age group overlapped and stated correctly that the difference is not significant. (References to 'insignificant' were not appropriate in the context of discussing statistical data.) However, few recognised how this related to an evaluation of the conclusion.

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